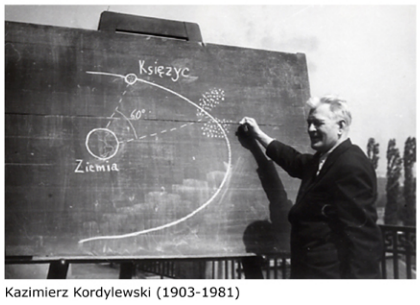
Institut für Raumfahrtsysteme
www.irs.uni-stuttgart.de

Universität Stuttgart

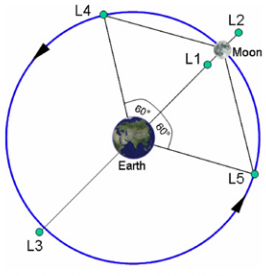
The Kordylewsky Clouds - An Example for a Cruise Phase Observation during the LUNAR MISSION BW1



Kazimierz Kordylewski (1903-1981)

In October 1956 the Polish astronomer Kazimierz Kordylewski (1903-1981) observed the Lunar Libration Clouds at the libration points L4 and L5 visually for the first time. In March and April of 1961 he took photographs of the clouds and published his findings in Acta Astronomica. Since then a number of observers have obtained visual evidence, photographic exposures or took space-based measurements.

The faint clouds are hard to detect from Earth and were never the primary target of a space based mission. We propose a dedicated search and measurement campaign for the Kordylewski Clouds during the cruise phase of the Lunar Mission BW1 spacecraft.



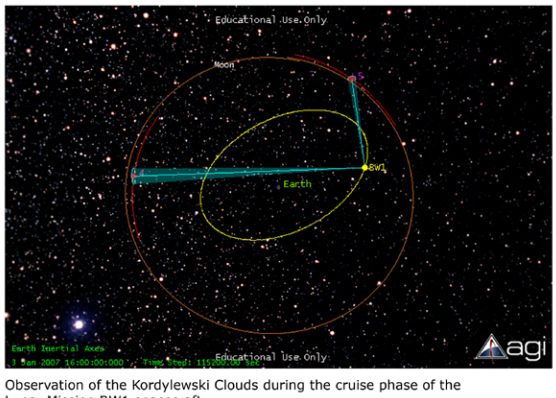
Position of the libration points of the Earth-Moon system

The contact times to the Lunar Libration Clouds and their equatorial coordinates at those times were calculated using the Satellite Tool Kit software developed by AGI (Analytical Graphics, Inc.)

In this case STK was used to solve the inter-visibility problems between a ground based observer, the Lunar Mission BW1 spacecraft and the L4 and L5 points. The observer's position was assumed to be the building of the Institute of Space Systems (IRS), Stuttgart, Germany.

The simulations show that it is possible to observe the clouds from the Lunar Mission BW1 spacecraft almost any time during the transfer through cis-lunar space.

A simulation conducted with a trajectory close to the last orbit before lunar capture (305,000x180,000 km, 21 deg inclination, similar to the SMART-1 capture orbit) showed the spacecraft can get as close as 58,000 km to the clouds. This close proximity will significantly enhance the observation quality.

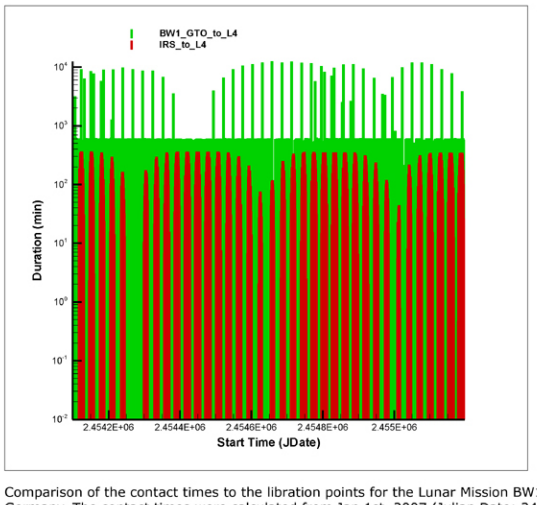


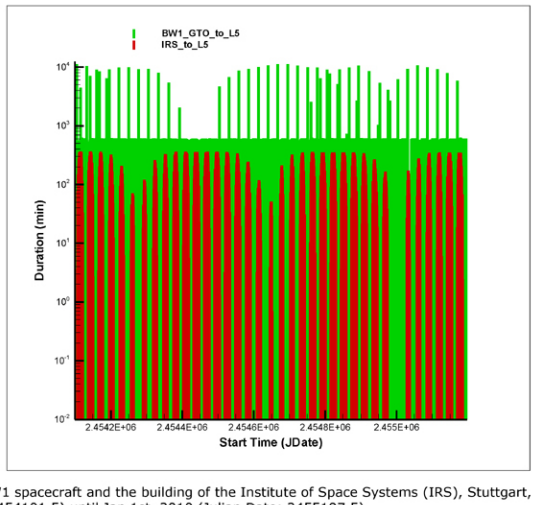
Observation of the Kordylewski Clouds during the cruise phase of the Lunar Mission BW1 spacecraft.

The contact times of a ground based observer to the L4 and L5 libration points are much shorter.

About 10 to 15 opportunities are available each month to observe the clouds from the assumed position. The contact duration lasts from a few minutes up to six hours.

The tables below list the longest contact durations and the equatorial coordinates for each month from February 2007 until February 2009.





Comparison of the contact times to the libration points for the Lunar Mission BW1 spacecraft and the building of the Institute of Space Systems (IRS), Stuttgart, Germany. The contact times were calculated from Jan 1st, 2007 (Julian Date: 2454101.5) until Jan 1st, 2010 (Julian Date: 2455197.5).
The ground based observations are constrained by a sun elevation angle of max. -18° and a lunar elevation angle of max. -1°. For the observation times from the spacecraft exclusion angles of 20° for the sun and the moon were assumed.

IRS - L4																							
Month	Access No	Start Date and Time [UTCG]				End Date and Time [UTCG]				Duration [min]	Begin				End								
											RA [HMS]		Dec [DMS]		RA [HMS]		Dec [DMS]						
Feb 2007	21	19	Feb	2007	19:31:12.124	20	Feb	2007	01:37:26.947	366,25	03:47:11.5071	E	25:08:24.4127	N	04:03:32.2076	E	26:00:19.5404	N					
Mar 2007	34	20	Mar	2007	19:54:17.331	21	Mar	2007	01:47:40.379	353,38	05:33:36.0615	E	28:31:39.7062	N	05:50:28.1167	E	28:35:00.7690	N					
Apr 2007	45	18	Apr	2007	20:20:11.156	19	Apr	2007	01:18:21.505	298,17	07:20:14.5582	E	26:32:27.9220	N	07:33:50.6530	E	25:55:27.1845	N					
May 2007	58	18	May	2007	21:54:41.988	19	May	2007	00:38:58.750	164,28	09:56:52.5887	E	14:01:13.5207	N	10:02:57.9996	E	13:19:44.7843	N					
Jun 2007	---	NO CONTACT								---	NO CONTACT												
Jul 2007	69	22	Jul	2007	22:08:39.359	23	Jul	2007	01:04:42.853	176,06	18:31:19.6989	E	27:46:36.9640	S	18:37:49.1656	E	27:37:28.5204	S					
Aug 2007	81	21	Aug	2007	21:27:19.027	22	Aug	2007	02:23:12.281	295,89	20:46:07.5233	E	20:36:23.9038	S	20:56:04.4908	E	19:44:22.4612	S					
Sep 2007	94	19	Sep	2007	20:53:01.814	20	Sep	2007	02:45:51.521	352,83	22:03:00.8558	E	12:47:12.7207	S	22:14:08.5697	E	11:28:18.7593	S					
Oct 2007	111	18	Oct	2007	20:50:19.015	19	Oct	2007	02:52:34.789	362,26	23:18:12.5846	E	03:11:16.2898	S	23:29:23.5077	E	01:41:49.5730	S					
Nov 2007	125	14	Nov	2007	18:41:14.277	15	Nov	2007	00:41:58.981	360,75	23:02:31.1182	E	05:01:55.4734	S	23:13:28.6831	E	03:35:42.7916	S					
Dec 2007	140	12	Dec	2007	17:43:36.962	12	Dec	2007	23:43:46.336	360,16	23:34:02.0863	E	00:35:21.1902	S	23:45:06.0180	E	00:52:47.6293	N					
Jan 2008	158	13	Jan	2008	21:52:06.656	14	Jan	2008	03:53:28.198	361,36	03:40:15.0200	E	24:54:28.8984	N	03:55:05.2816	E	25:38:44.4494	N					
Feb 2008	169	9	Feb	2008	19:39:23.341	10	Feb	2008	01:41:05.517	361,70	03:20:03.2018	E	23:49:31.4379	N	03:34:52.7531	E	24:41:50.9849	N					
Mar 2008	183	9	Mar	2008	20:01:25.018	10	Mar	2008	01:54:27.120	353,04	05:05:11.6765	E	27:46:22.6085	N	05:21:14.6968	E	27:56:13.8207	N					
Apr 2008	194	7	Apr	2008	20:28:00.378	8	Apr	2008	01:32:21.150	304,35	06:53:35.5215	E	26:26:55.8933	N	07:07:27.7877	E	25:54:49.9241	N					
May 2008	208	6	May	2008	21:06:04.178	7	May	2008	00:36:29.982	210,43	08:35:37.6957	E	20:12:03.8531	N	08:44:29.9065	E	19:27:18.5693	N					
Jun 2008	219	6	Jun	2008	22:42:31.960	6	Jun	2008	23:58:35.900	76,07	11:55:17.2635	E	03:01:14.1534	S	11:57:59.2784	E	03:22:11.6235	S					
Jul 2008	229	10	Jul	2008	22:30:57.969	11	Jul	2008	00:29:10.495	118,21	17:48:49.5302	E	27:29:22.5809	S	17:53:17.9934	E	27:26:52.5330	S					
Aug 2008	241	9	Aug	2008	21:44:35.211	10	Aug	2008	01:56:31.606	251,94	20:06:56.6769	E	22:01:25.9600	S	20:15:27.5526	E	21:24:05.9877	S					
Sep 2008	253	7	Sep	2008	21:00:01.021	8	Sep	2008	02:37:13.207	337,20	21:23:45.2836	E	15:14:26.0124	S	21:34:16.0638	E	14:07:56.1699	S					
Oct 2008	270	7	Oct	2008	21:46:33.628	8	Oct	2008	03:43:34.024	357,01	23:20:33.5222	E	01:08:49.2810	S	23:31:10.8986	E	00:13:34.7225	N					
Nov 2008	283	3	Nov	2008	19:34:12.304	4	Nov	2008	01:29:59.859	355,79	23:02:50.0443	E	03:13:39.6574	S	23:13:17.0604	E	01:53:36.9904	S					
Dec 2008	305	5	Dec	2008	23:09:35.993	6	Dec	2008	05:04:32.711	354,95	02:43:56.0432	E	21:13:28.5446	N	02:56:59.3060	E	22:07:37.1831	N					
Jan 2009	321	2	Jan	2009	22:08:58.746	3	Jan	2009	04:04:29.401	355,51	03:20:13.6704	E	23:38:42.2764	N	03:33:42.0994	E	24:20:55.3509	N					
Feb 2009	348	26	Feb	2009	19:00:28.516	27	Feb	2009	00:55:32.622	355,07	03:41:24.3413	E	24:39:50.9353	N	03:55:20.9804	E	25:15:16.9709	N					

IRS - L5																							
Month	Access No	Start Date and Time [UTCG]				End Date and Time [UTCG]				Duration [min]	Begin				End								
											RA [HMS]		Dec [DMS]		RA [HMS]		Dec [DMS]						
Feb 2007	23	11	Feb	2007	20:58:37.403	12	Feb	2007	03:02:13.189	363,596	12:30:21.0485	E	05:29:55.8666	S	12:41:35.6802	E	06:58:50.3978	S					
Mar 2007	38	11	Mar	2007	19:52:45.082	12	Mar	2007	01:52:33.362	359,805	12:57:43.4278	E	09:06:27.6894	S	13:08:58.1515	E	10:31:07.9201	S					
Apr 2007	50	9	Apr	2007	20:05:40.776	10	Apr	2007	01:29:49.053	324,138	14:18:24.7386	E	18:13:46.8680	S	14:29:39.4842	E	19:17:51.1927	S					
May 2007	64	8	May	2007	21:09:25.578	9	May	2007	00:37:37.781	208,203	15:53:22.9911	E	25:19:59.8812	S	16:01:35.0491	E	25:45:04.4958	S					
Jun 2007	76	8	Jun	2007	22:47:02.997	8	Jun	2007	23:58:45.623	71,71	19:45:33.9525	E	24:58:23.1333	S	19:48:33.8573	E	24:48:21.6295	S					
Jul 2007	83	11	Jul	2007	22:29:17.631	12	Jul	2007	00:29:57.037	120,657	00:52:05.8170	E	08:57:12.5220	N	00:56:24.0795	E	09:29:28.4745	N					
Aug 2007	96	10	Aug	2007	21:31:33.099	11	Aug	2007	01:52:36.557	261,058	03:14:12.8249	E	23:15:47.6796	N	03:24:24.8600	E	23:56:25.9619	N					
Sep 2007	108	8	Sep	2007	20:45:12.655	9	Sep	2007	02:14:02.876	328,837	04:51:26.2145	E	27:46:10.3647	N	05:04:38.5629	E	28:02:17.5650	N					
Oct 2007	124	8	Oct	2007	21:37:26.811	9	Oct	2007	03:38:05.448	360,644	07:28:08.8262	E	25:42:44.7558	N	07:41:18.8615	E	25:01:52.0196	N					
Nov 2007	137	4	Nov	2007	19:29:58.658	5	Nov	2007	01:29:40.191	359,692	07:10:38.5108	E	26:17:53.1546	N	07:23:56.3188	E	25:42:52.5967	N					
Dec 2007	153	2	Dec	2007	18:29:10.772	3	Dec	2007	00:27:52.341	358,693	07:47:01.5322	E	24:16:41.3064	N	07:59:48.8499	E	23:29:40.7862	N					
Jan 2008	189	31	Jan	2008	20:49:40.173	1	Feb	2008	02:49:56.504	360,272	11:52:25.8723	E	02:10:06.7351	S	12:02:55.6606	E	03:33:19.9395	S					
Feb 2008	206	28	Feb	2008	19:40:31.333	29	Feb	2008	01:39:45.088	359,229	12:17:56.7684	E	05:32:46.0744	S	12:28:30.5000	E	06:54:18.5842	S					
Mar 2008	223	28	Mar	2008	19:40:50.508	29	Mar	2008	01:20:06.472	339,266	13:30:25.9827	E	14:14:54.5221	S	13:41:04.4248	E	15:23:18.2251	S					
Apr 2008	237	27	Apr	2008	20:58:38.278	28	Apr	2008	01:03:30.722	244,874	15:44:45.8792	E	24:58:15.0358	S	15:53:51.1477	E	25:24:16.1684	S					
May 2008	252	27	May	2008	22:08:33.411	28	May	2008	00:06:05.375	117,533	18:20:39.8824	E	27:02:55.1982	S	18:25:24.4023	E	26:56:30.3919	S					
Jun 2008	262	30	Jun	2008	23:02:09.622	30	Jun	2008	23:53:33.710	51,401	00:26:58.6268	E	07:13:17.1880	N	00:28:54.4069	E	07:27:41.2438	N					
Jul 2008	271	30	Jul	2008	21:58:20.716	31	Jul	2008	01:30:02.636	211,699	02:53:15.3249	E	22:04:00.8128	N	03:02:11.6562	E	22:40:55.5652	N					
Aug 2008	280	28	Aug	2008	21:14:13.221	29	Aug	2008	02:37:45.779	323,543	04:33:32.2161	E	26:52:16.2885	N	04:47:41.2656	E	27:10:57.2209	N					
Sep 2008	292	26	Sep	2008	21:04:22.135	27	Sep	2008	02:59:06.520	354,74	06:18:20.7229	E	26:55:14.1358	N	06:33:06.2240	E	26:32:58.7400	N					
Oct 2008	306	24	Oct	2008	20:05:32.820	25	Oct	2008	02:02:02.536	356,495	06:59:47.9318	E	25:24:42.1492	N	07:13:50.7021	E	24:47:44.7732	N					
Nov 2008	320	21	Nov	2008	19:10:23.260	22	Nov	2008	01:05:54.632	355,523	07:40:39.6277	E	23:07:40.7718	N	07:53:56.7315	E	22:17:48.7051	N					
Dec 2008	339	23	Dec	2008	22:51:50.433	24	Dec	2008	04:47:07.625	355,287	11:30:39.1745	E	00:43:36.5496	S	11:41:08.2453	E	02:03:49.8338	S					
Jan 2009	352	19	Jan	2009	20:42:11.056	20	Jan	2009	02:37:35.867	355,414	11:15:21.2273	E	01:05:42.6594	N	11:25:54.5205	E	00:15:12.5535	S					
Feb 2009	365	16	Feb	2009	19:35:24.366	17	Feb	2009	01:30:51.014	355,444	11:42:47.7303	E	02:24:36.0414	S	11:53:25.6327	E	03:45:19.5205	S					

Longest observation opportunities of both Kordylewski clouds from the building of the Institute of Space Systems (IRS), Stuttgart, Germany.
For more detailed contact times and coordinates for your observatory please contanct Mr. Oliver Zeile (zeile@irs.uni-stuttgart.de).

Rene Laufer [1], Wilfried Tost [2], Oliver Zeile [1], Ralf Srama [3,1], Hans-Peter Roeser [1]
[1] Institute of Space Systems, Universitaet Stuttgart, Germany; [2] DLR-Institute of Planetary Research, Berlin-Adlershof, Germany; [3] Max-Planck-Institute for Nuclear Physics, Heidelberg, Germany
Contact: Institute of Space Systems (IRS), Universitaet Stuttgart
Pfaffenwaldring 31, 70569 Stuttgart, Germany
e-mail: laufer@irs.uni-stuttgart.de